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DISCLOSURE TITLE: Combined Use of Collision-Resolution and Collision-Avoidance Media-Access Communication Protocols

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DISCLOSURE TEXT:

Disclosed is method of combining two media-access protocols: using a collision-resolution protocol like ALOHA in a control channel for providing efficient access to a data channel for a large number of users, and using a collision-avoidance protocol like polling in the data channels for reliable real-time transmission.

Consider a point-to-multipoint data communication problem. One example is communication between the set-top-boxes at the homes and the associated headend in a traditional CATV coax plant. Another is communication between the base-site and the mobile users in a single cell of a wireless (cellular) system. In such a system, the total number of (active and inactive) users can be large while the number of active users is small.

Typical protocols used in such cases are ALOHA and Carrier Sense Multiple Access (CSMA or ethernet) which can

result in collisions among data packets and consequently are not suitable for real-time traffic like video and voice. In addition, these protocols do not use the available bandwidth efficiently since they involve retransmissions. We would like to devise a protocol (or protocols) for packet-switched communication by which the users in the system can have collision-free transmission and reception of (user) data packets. This implies that the users are allocated the available bandwidth in some fashion. One method would be to allocate bandwidth to both active and inactive users but this would be very inefficient if the total number of users is large.

This invention is described combines the use of a collision-resolution protocol like ALOHA which can support a large number of users with a bandwidth allocation (collision-avoidance) protocol like polling that is suitable for real-time traffic.

This invention is described in the context of last-mile communication in a traditional tree-shaped CATV network. The available bandwidth is divided into two bands: one for downstream communications (from the head of the CATV coax tree to the users) and the other for upstream communication (from the users to the head of the CATV coax tree).

Each band is further divided into a number of channels (e.g., each having a bandwidth of 6 MHz) but the number of active users is typically much larger than the number of channels so that each data channel must still be shared by multiple users.

Access to data channels by users is controlled by

means of a connection establishment procedure. This procedure is carried over dedicated control channels. There are two control channels: a forward control channel located in the downstream band and a reverse control channel located in the upstream band. Control channels are at fixed locations in a given system, and user receiver and transmitter are tuned to these pre-assigned frequencies upon powering on. Note that this requires that one channel be dedicated to control in both the downstream and upstream bands.

Since transmissions on the forward control channel are only from a single user viz., the System Controller (SC) at the head of the CATV coax tree, there is no sharing of this channel and consequently, no multiple access problem to deal with. However, the reverse control channel has to be shared by all the users on the coax tree. This is the environment to which the method disclosed here is applicable. One access protocol which can be provide efficient sharing of the control channel bandwidth is ALOHA, where each user wishing to transmit on this channel simply goes ahead and does so. Collisions are detected by a timeout mechanism and transmissions rescheduled for some random time in the future. The bandwidth of the control channel should be made sufficient to handle the expected volume of control information. Given that control information is typically only exchanged at the time of connection setup, the control load induced by each user on the system will be quite small. A large

number of users can, therefore, be supported with minimal control access delay on a control channel of moderate bandwidth.

When a station wants to establish a connection, it sends a connection request in the reverse control channel and listens to the forward control channel. When this request is received by the SC, it allocates a data channel in one or both directions (depending on the nature of this call) and transmits this information on the forward control channel.

The user then tunes its receiver and/or transmitter to the allocated data channel(s). After a downstream data channel has been allocated to a user, any further control information to the user is sent in-band on this channel. Similarly, if the user is allocated an upstream data channel, it sends further control information in-band in this channel. Otherwise, its transmitter remains tuned to the pre-assigned control channel.

As for the downstream control channel, the sharing of the downstream data channels between users can be readily achieved since there is only one source of traffic, the SC, which will ensure proper sequencing of transmissions on that data channel.

Upstream data channels also need to be shared by several users.

As in the case of the upstream control channel, this sharing requires a multiple access protocol because of the existence of several distinct traffic sources. In order to support real-time traffic (traffic which requires bounded delay guarantees) like video and voice, it is desirable to avoid collisions and

contentions altogether rather than allow them to occur and then recover from them as in ALOHA or ethernet-like protocols. Moreover, ethernet-like carrier sense protocols are difficult to implement since the medium is not broadcast. Therefore, the multiple access protocol we have chosen relies on polling by the SC of the users sharing an upstream data channel.

The polling protocol implements the sharing of the data channel bandwidth between multiple users as follows: Once an upstream connection is established, a user accumulates data in a transmit buffer at the set-top box till it receives a poll addressed to it from the SC. The poll specifies both the identity of the user which is granted permission to transmit and the maximum length of the transmission. The user transmits its accumulated data upto this maximum and ends it with a special character indicating the end of its transmission. Receipt of this character is used by the polling agent in the SC to send the next poll to another user sharing the same upstream data channel.

Disconnection is accomplished either by the user or by the SC by sending an appropriate control packet.

In summary, we have described a media-access method for communication over a broadcast, e.g., wireless, or partially broadcast, e.g., CATV, medium, that combines a collision-resolution protocol (like ALOHA) in one (or more) control channel(s) for the purpose of gaining access to data channels with a collision-avoidance

protocol (like polling) for sharing the data channels.